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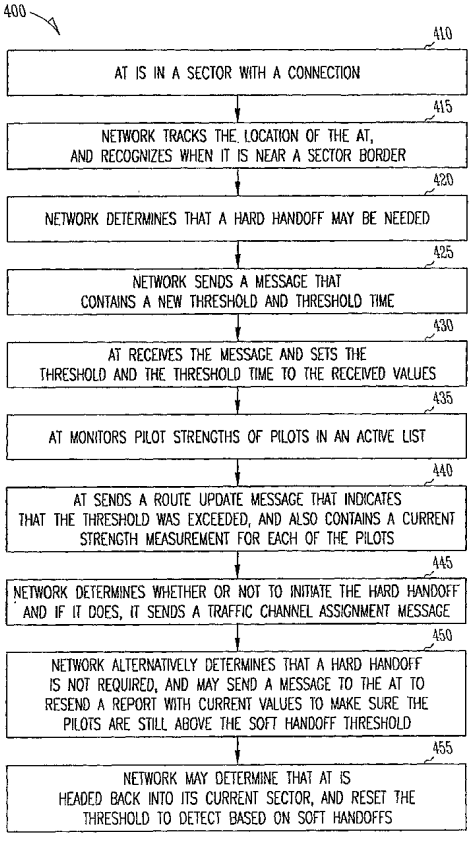
(54) Title: FORCED PILOT STRENGTH MODIFICATION



(57) Abstract: A wireless network detects when all the pilots in an Active Set for an access terminal (AT) are border cells. The network then sends a new PilotDrop threshold to the AT, and detects when the AT subsequently sends a RouteUpdate message indicating that any of the Pilots in the Active Set have fallen below the new PilotDrop threshold. The network may then send signals to the AT to trigger a handoff to the underlying carrier. The handoff may be a hard handoff, or effect a personality change of the AT.

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Forced Pilot Strength Modification

Related Application

[0001] This application claims the benefit under 35 U.S.C. 119(e) of United States Provisional Application serial number 60/648,187 (entitled Forced Pilot Strength Indication as a Trigger for Inter-Frequency Hard Handoff, filed January 28, 2005) which is incorporated herein by reference..

Background

[0002] Mobile stations, such as radio access terminals may move between multiple sectors in a radio access or wireless network. Many times, a soft handoff occurs between the sectors, such that the mobile station remains connected, and has communications handled by more than one sector. The handoff may be triggered by the mobile station measuring the strength of a pilot signal, and when it goes below a soft handoff level, informing the network that a soft handoff is required. In some cases, the mobile station has to be handed off to a sector that operates on a different frequency, or uses a different communication protocol. In such cases, there is a need for handing off the mobile station to the sector in a manner that is successful and results in a disconnection and reconnection of the traffic channel using the new protocol or frequency. This may be referred to as a hard handoff. Similar to the soft handoff case, the handoff event may also be triggered by the mobile station reporting the measured strength of pilot signal, or pilot signals. As common in both cases, the reporting of the pilot signal strength may be achieved by over-the-air messages such as a Route Update message as in the case of CDMA 1xEV-DO, a Pilot Strength Measurement message as in the case of CDMA 1xEV-DO, or other measurement reporting messages as in GSM and UMTS.

[0003] Some prior wireless networks, such as CDMA 1xRTT systems (products complying to IS-2000 family of standards) allow for periodic pilot strength reporting by a mobile station (MS), such as a radio access terminal, a PDA

with mobile wireless capabilities, or a laptop computer with similar equipment. CDMA 1xEV-DO standards (TIA-856-0) do not allow for this. A single request message does not trigger the MS to report pilot strengths periodically. An update of the TIA-856-0 standards, TIA-856 A 1xEV-DO Rev A provides the capability for the network to request RouteUpdate messages from a 1xEV-DO mobile station (also referred to as an Access Terminal or AT); however, in order for the RouteUpdates to be periodic, the network needs to send periodic Requests. This would result in unnecessary signaling which increases the burden of the wireless network to process and transmit such signaling messages. As this functionality is only available for IS-856 RevA compliant ATs, all existing and future ATs compliant with IS-856 Rev0 only would be excluded from any feature that is based on this functionality. It is expected that today and in the short to medium term these would be the majority of the ATs. Besides this functionality is only available for Rev A ATs; thus Rev 0 ATs, which are the majority of ATs in the field today, would be excluded from any feature that is based on this functionality. The term "Rev 0 AT" refers to an AT that complies with the standard 3GPP2 C.S0024, whereas the term "Rev A AT" refers to an AT that complies with standard 3GPP2 C.S0024-A. Both
standards are publicly available at:
http://www.3gpp2.org/Public_html/specs/tsgc.cfm

[0004] The prior art such as that in CDMA 1xRTT enables the periodic reporting of the AT (or MS) measurements of pilot strength to the wireless network when the AT enters an area composed of certain RF coverage sectors enables the wireless network to monitor the status of the RF signals received by the AT and, if necessary as in the case that the current pilot signal drops below a pre-determined threshold, direct the AT into a hard handoff. This prior art method however cannot be applied where such a mechanism is not available, e.g., 1xEV-DO Rev0, or is network resource inefficient, e.g., 1xEV-DO RevA. Furthermore, this prior art method can be potentially costly to network resources as the AT reports its pilot strength measurement for each period whether or not the RF signal has changed.

[0005] An alternative prior art method used for ensuring AT reporting of measured pilot strength is used a mechanism called Off-Frequency Search capability

of certain AT RF circuitry and from certain chipset vendors. Through this method, the vendor specific implementation at the AT circuitry ensures that the AT periodically tune to other RF frequencies and report these frequencies with its pilot strength should certain criteria are met. Similar to the case of ATs compliant with 1xEV-DO Rev0, these constitutes a subset of the available ATs, and thus limits the appeal and capability of the solution. This approach also has the disadvantage of introducing periodic disruptions of the traffic channel at the points in time when the AT scans for pilot signals on other frequencies. Another alternative prior art method may be applied to direct the AT into an inter-frequency hard handoff, where certain RF signals are designated as Beacon frequencies such that when the AT encounters these signals the wireless network automatically directs the AT into hard handoff. It is well-known within those skilled in the art that such beacons mandates added equipment cost and significant waste of RF coverage to the wireless network

Summary

[0006] A radio access network system tracks the location of an access terminal. When the network detects the access terminal is near a border sector, where it may be desired to hand off the access terminal to another sector, a pilot strength threshold in the access terminal is reset to a higher value.

[0007] The access terminal uses this higher value to compare to strengths of multiple pilot signals. When one or more pilot signals are lower than the higher value threshold, a message is sent to the network reporting the strengths of the pilot signals. The network may use this information to hand off the access terminal to a sector having different frequency or different protocol.

[0008] In a further embodiment, a timer is used to ensure that the pilot strength is below the threshold for more than a predetermined amount of time.

[0009] In one embodiment, the wireless network continuously tracks the location of the access terminal (AT) and monitors the pilot signal strength of the sector or sectors with which the AT communicate through one or more established traffic channels. In one embodiment of the present invention, the wireless network resets the pilot strength threshold to a higher value in the AT such that the AT will

report any pilot signal subsequently that is higher than this reset threshold, when the network detects that the AT is in near a border sector and where it may be desired to hand off the AT to another sector and over a different frequency from one that the AT currently has established traffic channel with the network.

[0010] The AT uses the reset high threshold to compare the strengths of multiple pilot signals that it is monitoring. When one or more pilot signals are lower than the higher value threshold, the AT automatically reports the strengths of these pilots. The exchange for the behavior of the network and the AT does not require any changes to the wireless technology standards in CDMA 1xEV-DO Rev0, CDMA 1xEV-DO RevA, CDMA 1xRTT, UMTS, and others; this ensures the wides possible applicability of the present invention.. The pilot strength threshold is an existing parameter of the standards. The network resets this threshold with no modification to existing signaling messages. The AT triggers this reporting with no modification of the existing standard behavior of the AT. The AT accomplishes this report through signaling messages existing in the current standards. The network may use the reported pilot information to hand off the AT from one sector to another and from one RF frequency to another. In one embodiment, a method is provided to trigger a pilot signal strength report in CDMA 1xEV-DO Rev0 that is not available in the standards. It may provide a method that is much more efficient to network resources in CDMA 1xEV-DO RevA. It may also provide an alternative that is more efficient in CDMA 1xRTT, UMTS, and similar wireless networks.

[0011] In a further embodiment of the invention, the wireless network does not reset this pilot strength threshold unless the set of pilots initially reported by the AT has changed within which one or more pilot signals are designated to be border sectors.

[0012] In a yet a further embodiment of the present invention, an existing timer value is also reset to ensure that the pilot strength is below the reset pilot strength threshold for more than a predetermined amount of time so as to provide a hystersis to mitigate any pilot strength ping-pong effects.

Brief Description of the Drawings

[0013] FIG. 1 is a block diagram illustrating motion of an access terminal with respect to coverage areas according to an example embodiment.

[0014] FIG. 2 is a block diagram illustrating a system border along multiple sectors according to an example embodiment.

[0015] FIG. 3 is a block diagram illustrating a border between two sectors according to an example embodiment.

[0016] FIG. 4 is a flow chart illustrating changing pilot strength signal thresholds and effecting a handoff as a function of such thresholds and measured pilot strength signals according to an example embodiment.

[0017] FIG. 5 is a flow chart illustrating further detail in changing pilot strength signal thresholds and effecting a handoff as a function of such thresholds and measured pilot strength signals according to an example embodiment.

Detailed Description

[0018] In the following description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific embodiments which may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural, logical and electrical changes may be made without departing from the scope of the present invention. The following description is, therefore, not to be taken in a limited sense, and the scope of the present invention is defined by the appended claims.

[0019] The functions or algorithms described herein are implemented in software or a combination of software and human implemented procedures in one embodiment. The software may consist of computer executable instructions stored on computer readable media such as memory or other type of storage devices. The term "computer readable media" is also used to represent any means by which the computer readable instructions may be received by the computer, such as by different forms of wireless transmissions. Further, such functions correspond to modules, which are software, hardware, firmware or any combination thereof.

Multiple functions are performed in one or more modules as desired, and the embodiments described are merely examples. The software is executed on a digital signal processor, ASIC, microprocessor, or other type of processor operating on a computer system, such as a personal computer, server or other computer system.

[0020] Various terms and abbreviations that may be used herein are described in the following table 1:

TABLE 1

1xEV-DO	1xRTT Evolution Data Optimized
1xEV-DO Rev0	1xEV-DO Revision A (i.e., IS-856 Revision 0 Compliant)
1xEV-DO RevA	1xEV-DO Revision A (i.e., IS-856 Revision A Compliant)
1xRTT	1x Radio Transmission Technology
AT	Access Terminal
BTS	Base Station Transceiver System
CDMA	Code Division Multiple Access
GGSN	GPRS Gateway Serving Node
GPRS	General Packet Radio System
HRPD	High Rate Packet Data (also referred to as 1xEV-DO)
MS	Mobile Station
MT	Mobile Terminal
Node.B	UMTS terminology for BTS
RAN	Radio Access Network
RNC	Radio Network Controller
UMTS	Universal Mobile Transmission System

[0021] In one embodiment, a 1xEV-DO radio access network is notified when a pilot strength at an access terminal (AT) drops below a certain threshold that is configured at the network, transmitted to the AT, and stored within the AT. The AT may notify the network when the pilot drops below EcThreshold (the value of PilotDrop used for triggering a hard handoff) in a border overlay cell using a single message. The approach is applicable to all revisions of 1xEV-DO ATs currently available. ATs may take many forms, including but not limited to PCMCIA data cards plugged into a data device such as a lap top, a wireless PDA or cellular phone.

[0022] In radio access terminal deployments where the coverage area of a carrier frequency is overlaid by one or more carrier frequencies, (or there is a

change in communication protocols or versions of protocols between geographically adjacent sectors of the same carrier frequency), as shown in FIG. 1 at areas 110 and 120, there is the need to hard handoff an AT 105 from an overlying carrier 110 to an underlying carrier 120 (or from one set of sectors on a carrier frequency to another set of sectors on the same frequency that use a different communication protocol or version of protocol), as the AT moves to the edge of coverage of the overlay (or protocol) as indicated by arrow 130. If a hard handoff is not triggered, the RF conditions of the AT 105 will deteriorate, until either the network loses reverse link supervision or the AT 105 loses forward link supervision and the connection drops. This problem can be corrected by triggering a hard handoff from the overlaid carrier 110 to the underlying carrier (or from the sectors that support one protocol to the sectors that support the other protocol). In doing this, the network prompts the AT 105 to acquire the underlay carrier 120 (or adjacent sectors), thus preventing a connection drop.

[0023] A pilot strength based hard handoff trigger mechanism is used to trigger a hard handoff, either to a different frequency, or different protocol. In one embodiment, the pilot strength based hard handoff trigger is used for frequency overlaid deployments (or adjacent protocol revision deployments) in 1xEV-DO systems; i.e., systems conforming to TIA-856-A, the CDMA2000 High Rate Packet Data Air Interface Specification. It may also be used in other technologies such as CDMA2000 1xRTT and or UMTS.

[0024] In a 1xEV-DO system, the AT sends a RouteUpdate message to request addition or deletion of a pilot to or from an 'Active Set'. A pilot is requested to be added to the active set when its strength is above a threshold PilotAdd. It is requested to be deleted from the active set if its strength is below a threshold PilotDrop for a consecutive PilotDropTimer seconds. The AT defaults to standard values of the thresholds PilotAdd, PilotDrop and PilotDropTimer; however the network is allowed to override these values at any time during the connection.

[0025] As an AT 210 moves to a coverage area of a border sector on the overlay carrier as seen in FIG. 2, the network needs to trigger a hard handoff when it determines that the AT is better served by the underlay, such as illustrated at 220.

One approach is to base this determination on the strength of the pilots reported by the AT. An algorithm is used that triggers hard handoff as the border pilot strength drops below a threshold, for example, an EcThreshold. In order to trigger hard handoff the network needs to be notified or made aware when the border pilot strength falls below EcThreshold. 1xEV-DO standard does not allow for the AT to periodically report pilot strengths.

[0026] When all the pilots in the active set are Border pilots, the network changes the PilotDrop threshold and the PilotDropTimer that is to be used by the AT. The network changes these values by sending an AttributeOverride message with attribute equal to SetManagementSameChannelParameters. The AT sends a RouteUpdate message whenever an active set pilot drops below PilotDrop for PilotDropTimer seconds. Changing PilotDrop to EcThreshold (the PilotDrop may be increased to a value other than EcThreshold) will cause a RouteUpdate message to be sent when any of the pilots drop below EcThrehsold. If the RouteUpdate is triggered by a Border pilot, and if the strongest Border pilot is below EcThreshold, the network triggers a hard handoff.

[0027] With this approach, it is possible that a heavily shadowed area very close to the Border base station will meet the pilot strength criterion and trigger handoff. Alternately, it is possible that an AT will drag out of the frequency border maintaining the connection, because of good signal quality. In order to limit the geographical area where the AT hands off, a secondary metric may be added, whereby a handoff based on EcThreshold is allowed if the Round Trip Delay (RTD) of the AT, as measured by the network, is above a Min_RTD threshold. As well, if the RTD is greater than Max_RTD threshold, a handoff is triggered regardless of the strength of the pilot.

[0028] In one embodiment, the threshold for soft handoffs is approximately -9dB. When the threshold is changed for detecting when to perform a hard handoff, the value used is between approximately -7.5dB to approximately -8dB. This value is actually higher, or a stronger signal than the soft handoff threshold. This allows the network to more reliably perform the hard handoff, either to a different frequency, or to a different protocol or protocol version. During a hard handoff, a

connection may need to be dropped in that the traffic channel established for the AT is terminated by the wireless network and then re-established in that a new traffic channel may be set up over the alternative RF frequency.

[0029] FIG. 3 illustrates an embodiment of a hard handoff that occurs when various conditions are satisfied at 300. An AT is located at a point 310 on the border of two cells 315 and 320, each of which may have multiple sectors. Point 310 lies within a border sector 325. Note that each carrier-sector has a distinct pilot. The term carrier-sector means a specific pairing of sector and carrier frequency. A network database stores a "border" state for each pilot. Furthermore, it can store separate state indications for a border for inter-frequency hard handoff, or a border for inter protocol version handoff.

[0030] When the AT is located on the border of two cells at 310, a first condition is satisfied, that of all pilots in an active set being defined as type border in a database. In this example, the AT or mobile device is not in a soft handoff position with other non-border sectors. A round trip delay (RTD) condition is defined as the RTD of the pilot with the shortest RTD. A second condition is that a shortest RTD is between a datafilled min at 330 and a max RTD 335 and the strength o f the strongest pilot in the active set falls below a datafilled Ec_threshold or the shortest RTD exceeds the max RTD 335.

[0031] The new PilotDrop threshold is not optimized for Active Set management. Hence when the PilotDrop threshold has been changed, the pilots that would otherwise remain in the ActiveSet would now request to be deleted from it. The network should now base the Active Set management on the actual pilot strengths reported by the AT and not on the AT's request using the 'KEEP' parameter in the RouteUpdate message.

[0032] FIG. 4 is a flowchart illustrating a process for performing hard handoffs of mobile access terminals. At 410, an AT is in a sector with a connection. At 415, the network tracks the location of the AT, and recognizes when it is near a sector border. At 420, the network determines that a hard handoff may be needed. This determination may be a function of network topology. At 425, the network

sends a message, such as an AttributeOverride message that contains a new threshold and threshold time.

[0033] At this point the AT receives the message and sets the threshold and threshold time to the received values at 430. At 435, the AT monitors pilot strengths of pilots in its active list, and if one or more active pilots falls below the threshold, the AT sends, as shown at 440, a route update message. The route update message indicates that the threshold was exceeded, and also contains a current strength measurement for each of the pilots.

[0034] At 445, the network determines whether or not to initiate the hard handoff. If it does, it sends a traffic channel assignment message (or a Redirect message, or a ConnectionClose message, depending on whether the hard handoff can be accomplished without closing and re-opening the connection) that includes either a new frequency where a good signal is expected to be available (for the Redirect case), or new pilot parameters (sector and frequency) for the traffic channel (for the traffic channel assignment case), or neither (for the Connection close case when switching to a new protocol or new protocol version). Alternatively, at 450, the network may determine that a hard handoff is not required (e.g., since not all pilots in the active set meet the handoff criteria), and may send periodically a message (such as the ResetReport message) to the AT to trigger it to resend a RouteUpdate report with current values to make sure the pilots are still above the soft handoff threshold. Note that after the AT receives a ResetReport, it is only required to send a RouteUpdate if one of the pilots is still violating one of the reporting thresholds, such as the PilotDrop threshold. Therefore the ResetReport will not always trigger a RouteUpdate message, e.g., if all pilots have gone back to not violating any thresholds. Still further, the network at 455 may determine that AT is headed back into its current sector, and reset the threshold to detect based on soft handoffs. The reset is also performed once the hard handoff has been accomplished. The network may command such a reset at the same time as the hard handoff, or after it is successfully accomplished.

[0035] FIG. 5 shows a more detailed flowchart for monitoring pilots and RTDs, and for performing hard handoffs at 500. At 505, the network is in a state

referred to as State A, and is monitoring route update messages sent by an AT. Parameters in the AT are set to monitor for a soft handoff. When a route update message is received by the network, it triggers step one at 510. At 510, if all active set pilots are of type border, then step two at 515 is performed. If not, the network continues in State A.

[0036] At step two 515, minimum round trip delays are compared to a round trip delay threshold, and if greater than the threshold, a message is sent at 517 to the AT, commanding it to change parameters to hard handoff parameters. An attribute override message is used in one embodiment to accomplish the change. A State B at 520 is then entered. If the minimum round trip delay is less than the threshold as determined at 518, State A is maintained at 505.

[0037] In State B 520, the parameters of the AT have been changed for hard handoff. At 525, the round trip delay is monitored, and if the minimum round trip delay is greater than a maximum threshold, a handoff is triggered at 560. Otherwise, the AT remains in State B and continues to monitor. At 530, route update messages are monitored by the network. Five cases may be handled in one embodiment. At 535, if the strongest pilot is weaker than a pilot drop threshold, a handoff is triggered at 560. At 540, if a pilot that is not the strongest pilot is weaker than a pilot drop threshold, a reset report is periodically sent to the AT to trigger a route update message. This ensures that it will be known when the pilot eventually crosses the pilot drop value of a soft handoff. State B is again entered at 520.

[0038] At 545, if a pilot has dropped below a pilot drop threshold for soft handoff, it is dropped from the active set, and State B is entered at 520. If one of the pilots in an active set is not of type border, the parameters of the AT may be reset to soft handoff values at 550, and State A may be entered at 505. A last case is shown at 555 catches anything not falling into the previous cases, and essentially maintains the network and AT in State B. Trigger handoff 560 results in a reset of channel parameters in the AT for either a new frequency, different protocols, or different version of a protocol, or any other type of non-soft handoff, and then causes the network and AT to enter State A at 505.

[0039] A good inter-frequency hard handoff will become increasingly important as revision A of 1xEV-DO is rolled out, or as the amount of traffic demand in the network increases requiring the use of multiple carrier frequencies in some areas. It is reasonable to expect that a fair number of deployments will have revision A overlaid on Revision 0. As said above, the solutions for hard handoff in 1xEV-DO that we are aware of are based on a Pilot Beacon or other-frequency reporting by the AT.

[0040] In the case of a Beacon trigger, as soon as the AT reports a Border Pilot, a hard handoff to the underlay is triggered. This has the disadvantage that the Border sector is not adequately utilized and results in wasted capacity. Using the algorithm described above, the AT is allowed to stay on the Border sector as long as the pilot strength is above a certain threshold. The network will be notified when the pilot strength falls below a certain threshold. The network triggers handoff only when the AT reaches the edge of a border sector; this is in contrast to the beacon trigger where an AT is handed off as soon as it is in the coverage area of a border sector.

[0041] A handoff trigger based on off-frequency reporting by the AT is an effective hard handoff trigger mechanism; however only later ATs, and those willing to expend / redirect receiver resources to other frequencies, report off-frequency conditions. This approach will limit the application to a small subset of 1xEV-DO ATs available in the market. The pilot strength based handoff trigger, on which this invention is based, is a more universal approach, in that it can be applied to all revisions of ATs in the field today.

[0042] The Abstract is provided to comply with 37 C.F.R. §1.72(b) to allow the reader to quickly ascertain the nature and gist of the technical disclosure. The Abstract is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

[0043] While specific names for signals and messages are used in the present application, such names are not meant to be limiting to any particular communication standard unless so indicated, and instead, should be interpreted as

any type of communication that may serve the particular function intended. Examples include PilotDrop, PilotDropTimer, RouteUpdate and AttributeOverride messages.

CLAIMS

1. A method comprising:

detecting when all the pilots in the Active Set for an access terminal (AT) are border cells;

sending a new PilotDrop threshold to the AT;

detecting when the AT subsequently sends a RouteUpdate message indicating that any one or more of the Pilots in the Active Set have fallen below the new PilotDrop threshold; and

sending signals to the AT to trigger a handoff to the underlying carrier, or different set of pilots on the same carrier where such pilots use a different protocol or protocol version.

2. The method of Claim 1 wherein sending the new PilotDrop threshold is accomplished using an AttributeOverride message.

3. The method of claim 1 wherein the PilotDrop threshold includes a PilotDropTimer that is used to identify the amount of time a pilot has fallen below the new PilotDrop threshold prior to sending the RouteUpdate message.

4. The method of claim 1 wherein the handoff comprises a change in personality of the AT.

5. The method of claim 4 wherein a change in personality comprises a change to a different version of a communication protocol.

6. The method of claim 1 wherein the handoff comprises a hard handoff.

7. The method of claim 1 wherein a handoff is triggered if a strongest pilot in the Active Set is weaker than a pilot drop threshold after the AT has received the new PilotDrop threshold.

8. The method of claim 1 and further comprising:

monitoring round trip delays; and

if the minimum round trip delay of pilots in the Active Set is greater than a max round trip delay threshold, triggering a handoff.

9. The method of claim 1 wherein the network comprises a wireless 1xEV-DO network.

10. A method comprising:

detecting when all pilots in the Active Set for an access terminal (AT) are border sectors;

receiving a new PilotDrop threshold when all pilots in the Active Set for an access terminal (AT) are border sectors to the AT;

detecting if any of the Pilots in the Active Set have fallen below the new PilotDrop threshold;

sending a RouteUpdate message indicating that any of the pilots in the Active Set have fallen below the new PilotDrop threshold; and

receiving signals for a handoff to the underlying carrier or new set of pilots on the same carrier requiring the brief closure of the connection.

11. The method of claim 10 wherein the RouteUpdate message includes a pilot strength indication for all pilots in the Active Set.

12. The method of claim 10 wherein the PilotDrop threshold includes a PilotDropTimer that is used to identify the amount of time a pilot has fallen below the new PilotDrop threshold prior to sending the RouteUpdate message.

13. The method of claim 10 wherein the handoff comprises a change in personality of the AT.

14. The method of claim 13 wherein a change in personality comprises a change to a different version of a communication protocol.

15. The method of claim 10 wherein the handoff comprises a hard handoff, or redirection to another frequency, e.g., in another band.

16. A wireless 1xEV-DO network that triggers a non-soft handoff from an overlay carrier to an underlying carrier, or to a separate set of sectors of the same carrier, the network comprising:

means for detecting when all the Pilots in the Active Set for an access terminal (AT) are border sectors of an overlay carrier;

means for sending a new PilotDrop threshold and PilotDropTimer to the AT;

means for detecting when the AT subsequently sends a RouteUpdate message indicating that any of the Pilots in the Active Set have fallen below the PilotDrop threshold for at least the PilotDropTimer period of time; and

means for sending signals to the AT to effect a handoff to the underlying carrier, or separate set of sectors on the same carrier using a different protocol or protocol version.

17. The network of claim 16 wherein the means for sending a new PilotDrop threshold and PilotDropTimer to the AT comprises an AttributeOverride message.

18. The network of claim 16 wherein the handoff comprises a change in personality of the AT.

19. The network of claim 18 wherein a change in personality comprises a change to a different version of a communication protocol.

20. The network of claim 16 wherein the handoff comprises a hard handoff.

21. The network of claim 16 and further comprising:

means for monitoring round trip delays; and

means for triggering a handoff if the minimum round trip delay of pilots in the Active Set is greater than a max round trip delay threshold.

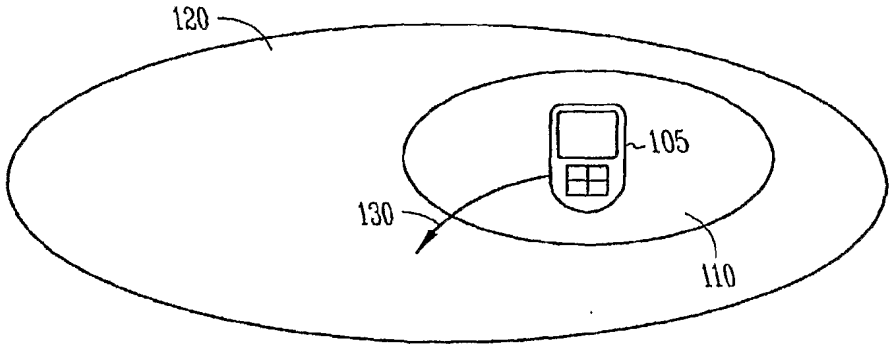
120
105
130
110

FIG. 1

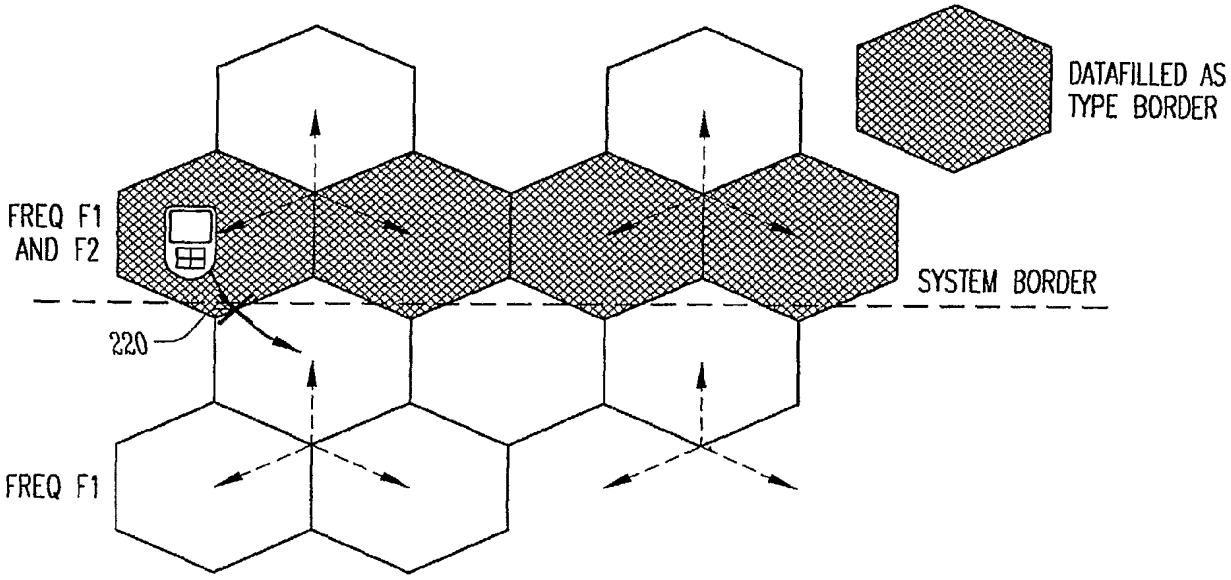
DATAFILLED AS
TYPE BORDER
FREQ F1
AND F2
SYSTEM BORDER
220
FREQ F1

FIG. 2

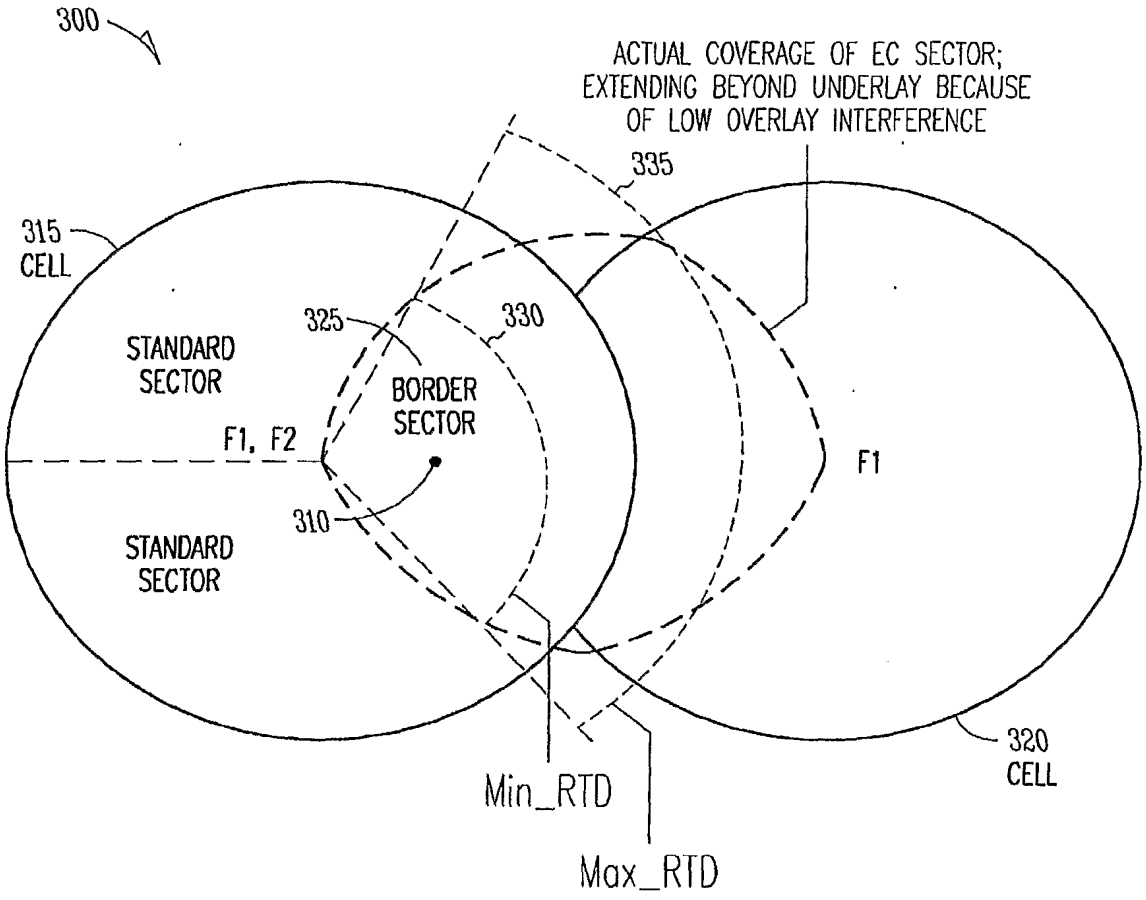
300
ACTUAL COVERAGE OF EC SECTOR;
EXTENDING BEYOND UNDERLAY BECAUSE
OF LOW OVERLAY INTERFERENCE
335
315
CELL
325
330
STANDARD
SECTOR
BORDER
SECTOR
F1, F2
F1
310
STANDARD
SECTOR
320
CELL
Min_RTD
Max_RTD

FIG. 3

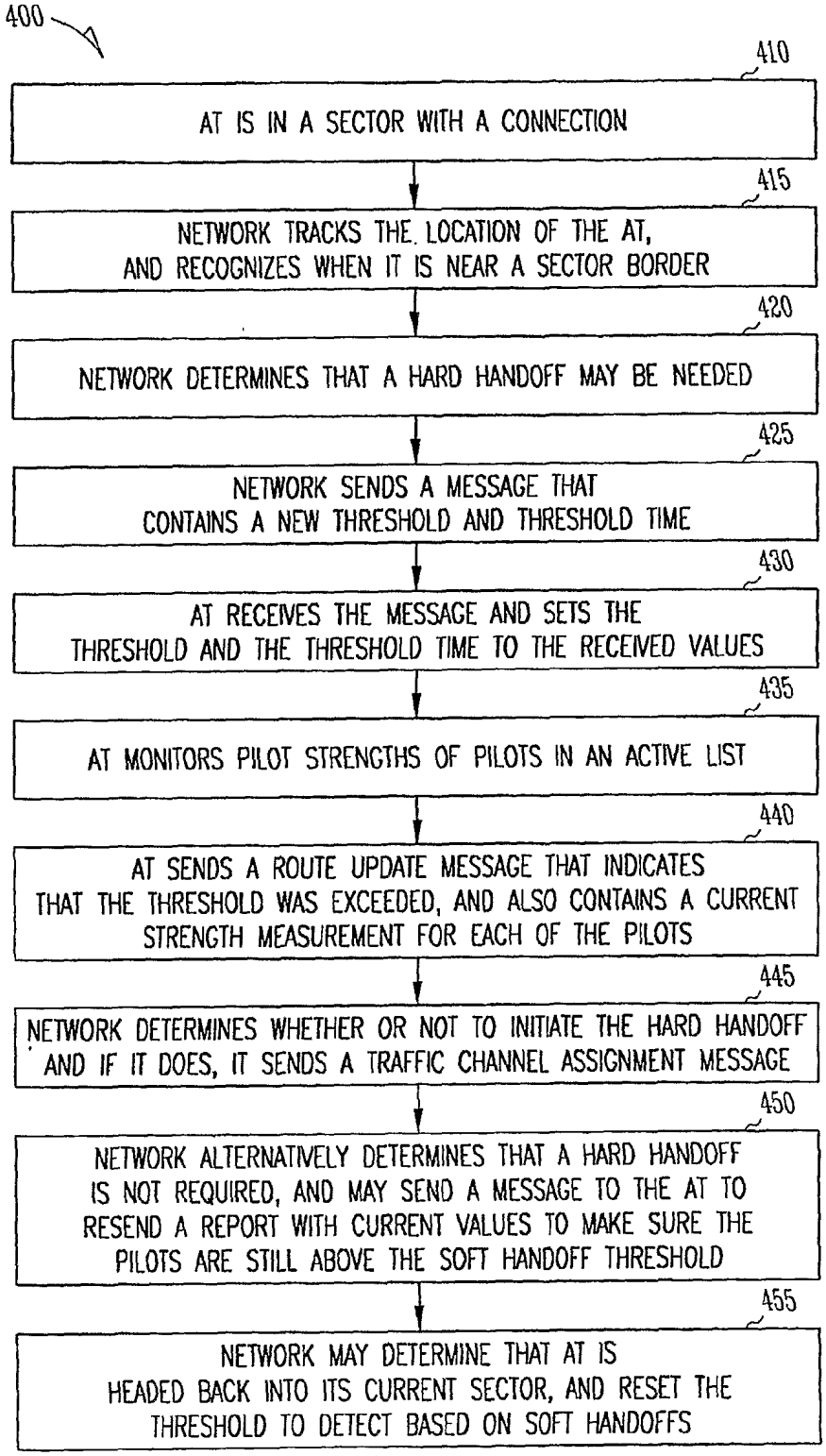
400
410
AT IS IN A SECTOR WITH A CONNECTION
415
NETWORK TRACKS THE LOCATION OF THE AT, AND RECOGNIZES WHEN IT IS NEAR A SECTOR BORDER
420
NETWORK DETERMINES THAT A HARD HANDOFF MAY BE NEEDED
425
NETWORK SENDS A MESSAGE THAT CONTAINS A NEW THRESHOLD AND THRESHOLD TIME
430
AT RECEIVES THE MESSAGE AND SETS THE THRESHOLD AND THE THRESHOLD TIME TO THE RECEIVED VALUES
435
AT MONITORS PILOT STRENGTHS OF PILOTS IN AN ACTIVE LIST
440
AT SENDS A ROUTE UPDATE MESSAGE THAT INDICATES THAT THE THRESHOLD WAS EXCEEDED, AND ALSO CONTAINS A CURRENT STRENGTH MEASUREMENT FOR EACH OF THE PILOTS
445
NETWORK DETERMINES WHETHER OR NOT TO INITIATE THE HARD HANDOFF AND IF IT DOES, IT SENDS A TRAFFIC CHANNEL ASSIGNMENT MESSAGE
450
NETWORK ALTERNATIVELY DETERMINES THAT A HARD HANDOFF IS NOT REQUIRED, AND MAY SEND A MESSAGE TO THE AT TO RESEND A REPORT WITH CURRENT VALUES TO MAKE SURE THE PILOTS ARE STILL ABOVE THE SOFT HANDOFF THRESHOLD
455
NETWORK MAY DETERMINE THAT AT IS HEADED BACK INTO ITS CURRENT SECTOR, AND RESET THE THRESHOLD TO DETECT BASED ON SOFT HANDOFFS

FIG. 4

500

505 **State A**: Network is monitoring RouteUpdateMessage (RUM) sent by AT; SetManagementParameters are defaults, i.e., set for softhandoff. A RUM triggers step 1.

510 1. Are all ActiveSet pilots of type Border; if yes goto step 2; else goto state A

515 2. is min{ActiveSet RoundTripDelay (RTD)} > datafilled min_RTD_Threshold

517 if yes, send Attribute Override Message to change SetManagementSameChannelParameters; changing PilotDrop Threshold to HHO_pilotdrop_Threshold. Go to StateB.

518 If no, go to State A.

520 **State B**. SetManagementParameters have been changed for HHO.

525 Monitor RTD; if min{Active set RTD} > datafilled max_RTD_Threshold; Go to **Trigger Handoff**; else stay in State B.

530 Monitor RUM: A RUM triggers one of the following cases:

535 Case 1: Strongest Pilot is weaker than the Pilot_drop_ threshold; Go to **Trigger Handoff**;

540 Case 2: A pilot (that is not the strongest pilot) is weaker than pilot_drop_threshold; Periodically send ResetReport to trigger RUM. This is to know when the pilot eventually crosses PilotDrop value for softhandoff. Go to stateB;

545 Case 3: A pilot has dropped below PilotDrop threshold for soft handoff; Drop the pilot from active set; go to state B.

550 Case 4: One of the pilots in active set is not of type Border; Reset the SetManagementSameChannelParameters i.e., set the pilotDrop threshold for softhandoff and go to Step A.

555 Case 5: anything other than Cases 1-4, go to State B;

560 **Trigger Handoff :** Reset the SetManagementSameChannelParameters; i.e., set PilotDrop threshold for SoftHandoff. Send handoff notification. Goto State A.

FIG. 5

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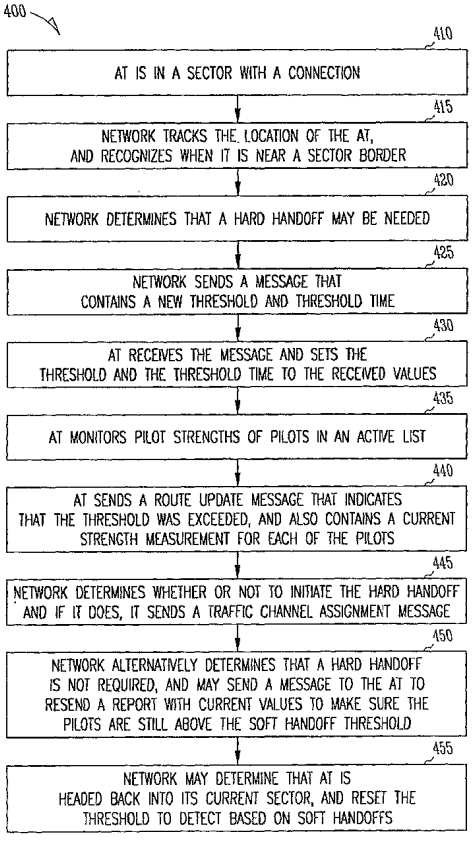
[Continued on next page]

(54) Title: FORCED PILOT STRENGTH MODIFICATION



(57) Abstract: A wireless network detects when all the pilots in an Active Set for an access terminal (AT) are border cells. The network then sends a new PilotDrop threshold to the AT, and detects when the AT subsequently sends a RouteUpdate message indicating that any of the Pilots in the Active Set have fallen below the new PilotDrop threshold. The network may then send signals to the AT to trigger a handoff to the underlying carrier. The handoff may be a hard handoff, or effect a personality change of the AT.

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EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, E	US 2006/0166671 A1 (RAJKOTIA et al.) 27 July 2006 (27.07.2006): abstract, paragraphs 0008, 0009, 0044	1-21
A	US 6,782,261 B1 (AHMED et al.) 24 August 2004 (24.08.2004): abstract, col. 2: lines 37-50, col. 4: line 45 - col. 5: line 10, col. 5: line 56 - col. 6: line 18	1-21

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